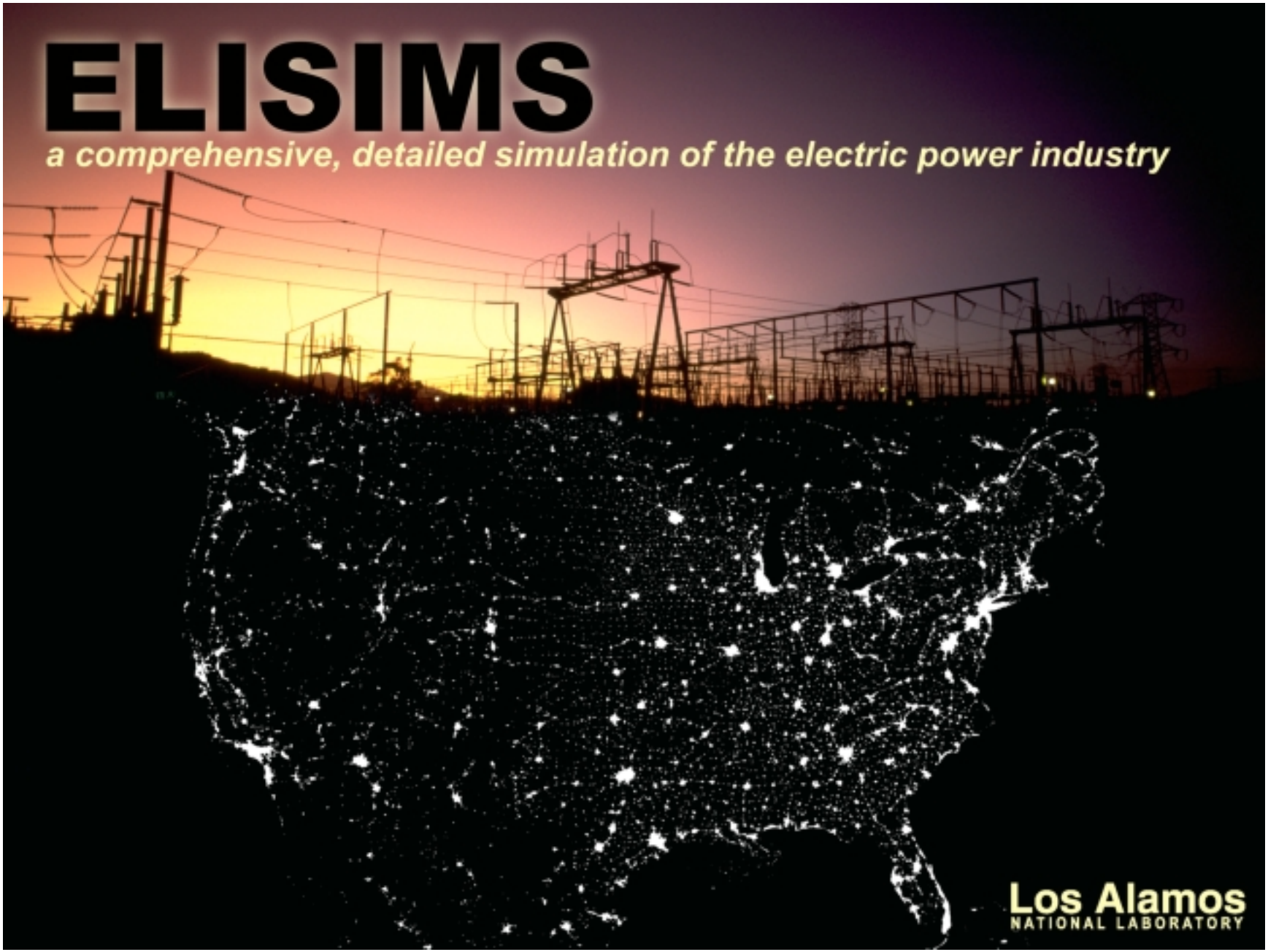

ELISIMS
a comprehensive, detailed simulation of the electric power industry
Los Alamos
NATIONAL LABORATORY

ELISIMS is a . . .

. . .Comprehensive

Detailed Simulation

of the *Electric Power Industry*

Continental scale: North America

Resolved to individual customers and corresponding system components

Driven by evolving (restructured) market dynamics

Market Dynamics (individual people) and Power Flow Dynamics are *tightly* interlinked!

ELISIMS Supports DOE Priorities

- "Electricity restructuring is among one of the hottest issues. . . . The proposed federal legislation will provide the tools needed to ensure that electricity markets operate as competitively and reliably as possible."

  — *Secretary Bill Richardson, April 15, 1999*

- ELISIMS is one such tool; it tightly integrates electrical engineering dynamics with market dynamics

ELISIMS Serves a Spectrum of Applications

- Analyses of proposed policies and regulations
  - Market operation
- Market power surveillance
- Technological analyses
  - Reliability, security, and control
- System operation
  - Congestion and contingency analyses

ELISIMS Addresses a Massive, Complex Problem

- The combinatorics are staggering
  - 6,000 to 17,000 generators
  - 50,000 to 140,000 transmission lines
  - 40,000 to 100,000 substations
  - 130,000,000 end-user customers
- The multiple time-scales are interlinked
  - Days to start big plants
  - Half-hour intervals for markets and dispatch planning
  - Tens of minutes in inertia and operator responses
  - Fractions to tens of seconds in automated responses
  - An instant to turn your lights on or off

ELISIMS is Natural to Los Alamos

- Expertise and experience in both phenomenological and human-in-the-loop simulations
- Experience in electric system analysis for DoD
- ASCI supercomputer capabilities
  - Delphi

ELISIMS Prototype is Finely Resolved

- Continuous market entities*:*
  - End Users (individual customers) exercise choices,
  - Generators post availability and f.o.b. prices,
  - Transmission Operators offer contract-path pricing,
  - Market Operator finds least (total) cost contracts,
  - System Operator calculates true path loading with each sequential contract and posts congestion prices, and
  - The process recycles through all demand and/or supply.

Generators

- Generators post a schedule of power availability

Day Ahead Availability Schedule

Hour	Available,MW	Price,$/MW
1	435	$45.00
2	455	$43.50
3	564	$41.50
4	228	$48.50
5	455	$49.50
6	455	$49.50
7	455	$48.50

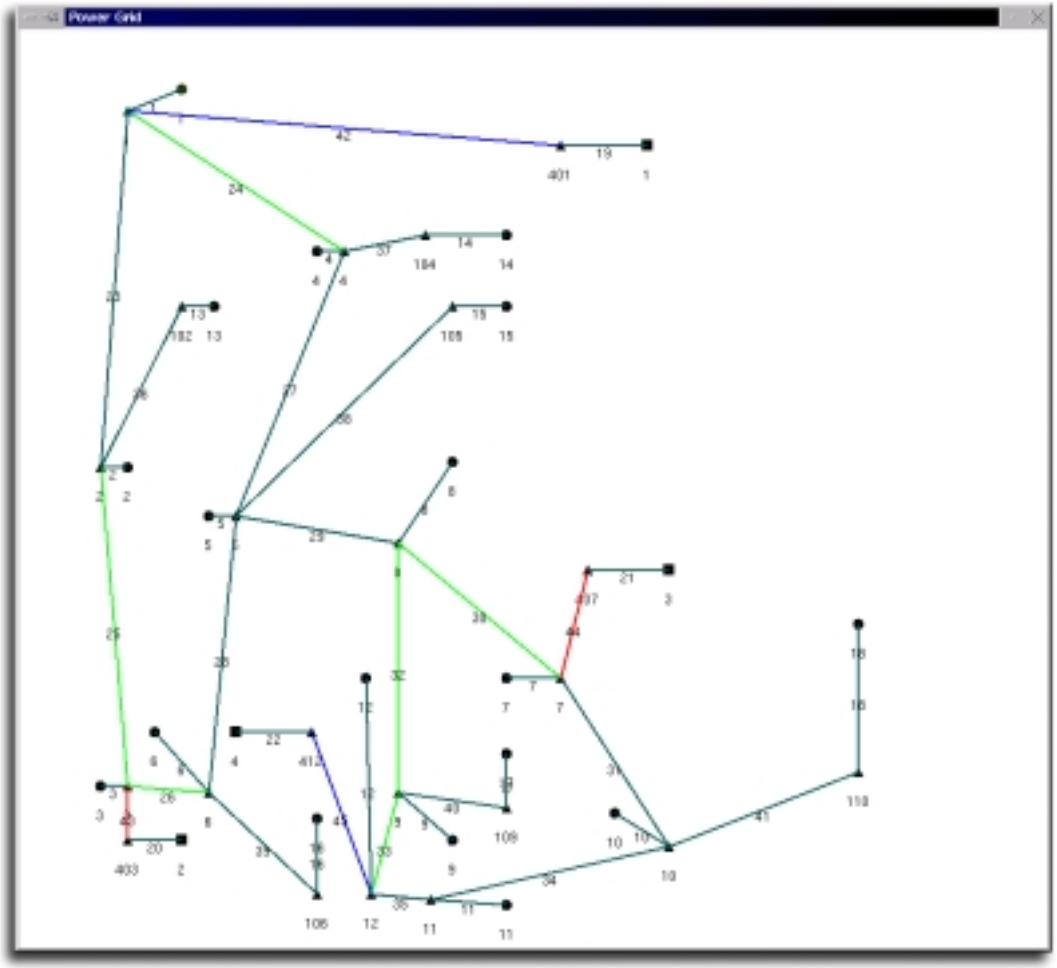
Consumers

- Consumers post a schedule of power demand

Day Ahead Demand Schedule

Hour	Demand,MW
1	43
2	45
3	50
4	60
5	75
6	75
7	60

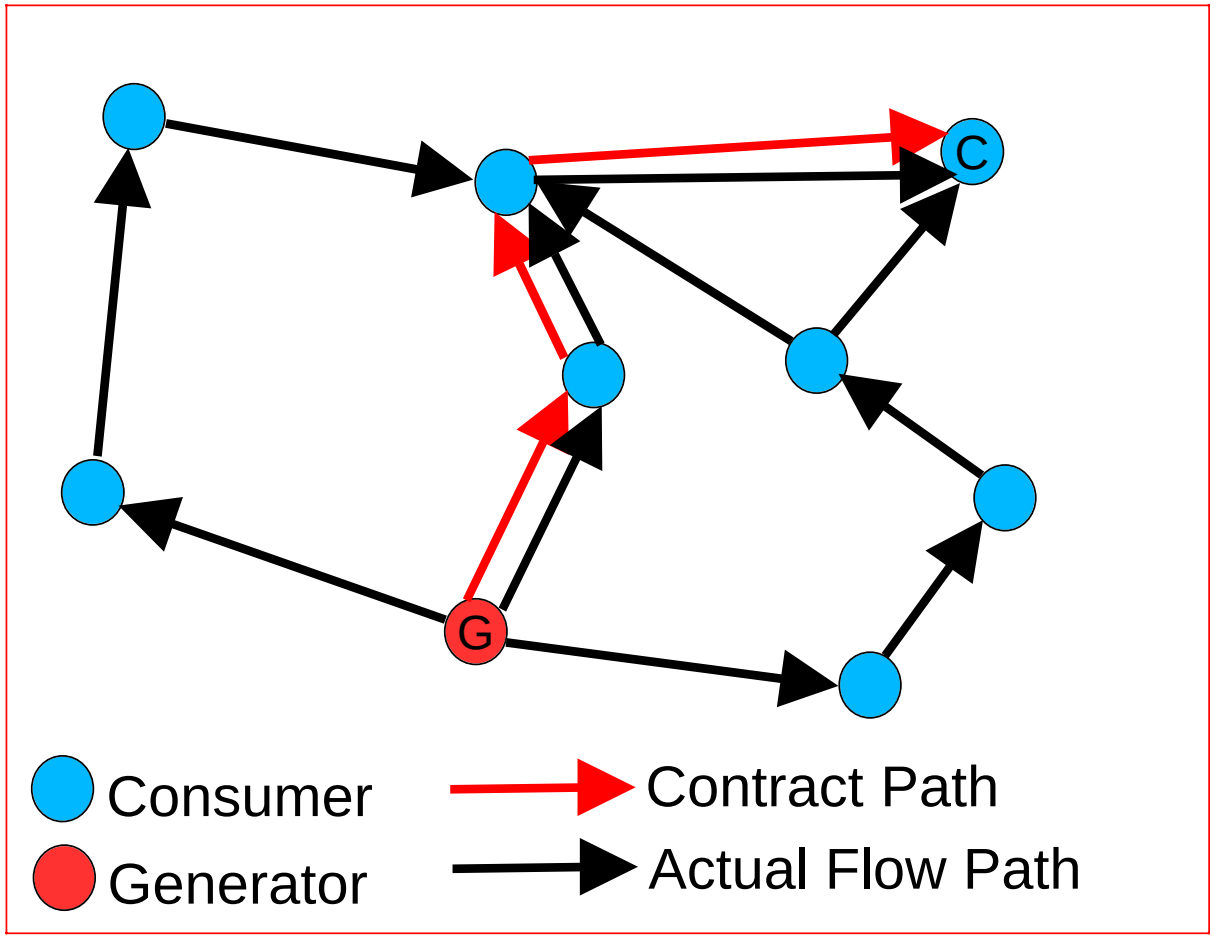
Power Grid



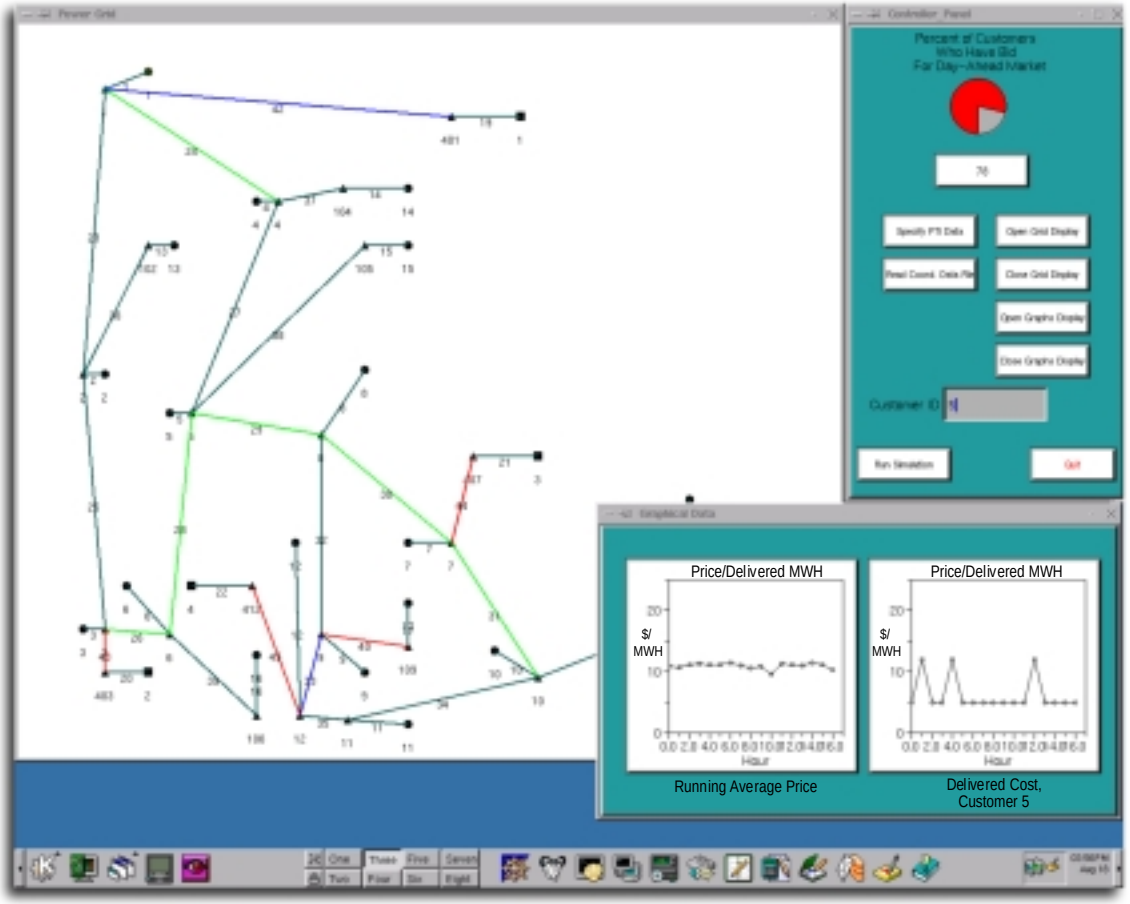
ELISIMS Links Market Dynamics with Electrical Dynamics

- For each hour in a 24-hour day-ahead market
  - The Market Operator finds the best price for power and transmission for one customer at a time taken at random (contract path)
  - The System Operator then verifies the feasibility for each such transaction and then calculates resulting true transmission path loads (loop flows)
  - The Market Operator posts updated transmission prices for all paths, thereby discouraging congestion, and then cycles back to the next customer

Contract Path



Model Interface



The Prototype is an Important Milestone

- We completed it on time
- We now have a design for interfacing market models with the electrical power infrastructure
- The prototype is a design test-bed
- It can be used as a market model test-bed
- The prototype can generate performance data for use in scaling the application

ELISIMS is Partnering with Cal-ISO

- Collaboration w/ California Independent System Operator
  - Non-Disclosure Agreement in place
  - CRADA being negotiated
  - We've applied for the required export license
  - Cal-ISO has tasked ECCO Int'l to work with LANL
    - Well-known ex-PG&E analysts
  - Extending prototype to useful problems
    - FERC interest in multi-state ISOs (perhaps all WSCC)
    - Possible Cal-ISO expansion to neighboring states
    - Effects of separation or combination of market and system operators
      - California now separate, PJM now combined

LANL is Planning Broader Future Development

- Planned simulation development
  - Other and multiple co-existing market protocols
  - Implement strategic behavior by market entities
    - Include reselling
  - Monitor market performance
    - Measure efficiency/detect power
  - Load forecast methods
    - Synthetic Population method from TRANSIMS
    - Service area estimation by cellular automata
  - Synchronous capacitors, FACTS, DC links, renewable generation
  - Utilize ASCI's parallelism
    - Redesign application entities and solvers
  - Extend to voltage collapse and generation stability applications